FIELD OF THE INVENTION

This invention relates to a machine for installing clamping or compression rings by forcibly reducing the diameter thereof by shrinking and is a continuation-in-part application of the Provisional Application Serial No. 60/011,984, filed on February 21, 1996. This application claims Benefit of Provisional Application Ser. No 60/032,005 Filed Nov. 25, 1996.

BACKGROUND OF THE INVENTION

Various clamping devices are known in the prior art for fastening, for example, hoses or axle boots onto nipples or axle stubs. So-called open hose clamps which are made from band material and adapted to be mechanically interconnected before tightening the same are usually provided with means for tightening the clamp, such as a screw or bolt, a worm drive or a so-called "Oetiker" ear as disclosed in **U.S. Patent 4,299,012.** On the other hand, endless clamping rings made from tubular stock are also known to be used for the same purpose. These endless clamps are tightened, for example, also by the use of a so-called "Oetiker" ear as disclosed in **U.S. Patent 2,614,304** or with a machine for shrinking the ring whereby such a machine may be hydraulically, pneumatically, mechanically or magnetically actuated. However, many of these types of machines are very expensive and therefore out of reach for the ordinary after market. Nor are many of such machines of the portable type as needed, for example, for demonstration purposes of the use of such shrinkable clamping or compression rings.

The endless types of clamps or compression rings are manufactured, for example, by sawing-off, punching-off or cutting-

off ring-like segments from tubular members and have been used, for example, in the automotive industry with the use of so-called Magnaform machines which electromagnetically shrink the rings. Apart from costs, these machines are very noisy in operation.

Crimping tools are also known in the art for crimping various devices, such as with electrical cable connection, in the oil industry for connecting pipe sections, etc. These crimping tools normally include oppositely directed tapering surfaces on segments of ring-like parts for engagement with correspondingly shaped surfaces on projections of the parts to be connected.

SUMMARY OF THE INVENTION

The use of such clamping or compression rings is becoming increasingly popular because relatively inexpensive clamping or compression rings have become available which can be manufactured from band material and are interconnected by a so-called puzzle-lock arrangement capable of withstanding significant tensional forces, as disclosed, for example, in **U.S. Patents 5,001,816** and **5,185,908.** To demonstrate the use of such clamping or compression rings and/or permit actual use thereof in the after-market requires a machine which is relatively cost-effective and easy to use.

Accordingly, it is an object of the present invention to provide a machine for installing clamping or compression rings by shrinking the same onto the object to be fastened which is relatively simple in construction and cost-effective as well as easy to use.

The machine according to one embodiment of this invention consists of segmental slide members constrained to move along circular paths within a housing when drawn toward one another, respectively, moved apart from one another, whereby the internal surfaces of the segmental slide members have surface portions that decrease in radius with respect to the center of the machine and are adapted to engage with complementary abutment surfaces provided on segments having circularly shaped internal clamping surfaces so that these circular surfaces are reduced in diameter as the slide members are moved toward one another and the clamping or compression rings placed on the inside of the segments are thereby forcibly shrunk.

According to another feature of an embodiment of this invention, the segmental slide members are provided with elongated openings all disposed on a constant radius and having a constant width for engagement with roller members mounted on pins supported in the housing and on the housing cover.

According to still another feature of an embodiment of this invention, the segments are provided with raised portions adapted to engage in channels cut into a raised circular portion of the housing bottom so as to constrain movement of the segments to radial directions, whereby spring elements are inserted into grooves in the housing bottom disposed at right angle to the channels and adapted to engage with complementary grooves in the raised portions of the segments so as to urge the segments radially

outwardly when the sliding members are moved in the opening direction.

According to still another feature of a preferred embodiment of this invention, a spindle is used having oppositely directed threads at the two ends thereof which are adapted to engage with trunion-like pivot members pivotally retained in radial arm portions forming radial extensions of the segmental slide members to draw the slide members toward one another and away from one another along the circular paths. To keep the spindle centered, a circular dish-like member fixedly arranged on the spindle is adapted to rotate in a groove of a centering plate fixed to the housing.

According to another embodiment of this invention, the segmental slide members are connected with a slide carriage, constrained by a spline connection to move rectilinearly within the housing for the slide carriage, whereby rectilinear to-and-fro movement is imparted to the slide carriage by a spindle freely rotatable relative to the slide carriage but fixed for axial movement in unison therewith. The spindle thereby engages with a stationary nut member so that the spindle will experience axial movement as it is rotated. The connection between the segmental slide members and the slide carriage is realized by pressure rollers which are connected with the slide members and which engage in angularly disposed channels in the slide carriage so that the pressure rollers are caused to approach one another, respectively, spread apart depending on the direction of movement of the slide carriage.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the present invention will become more apparent from the following description when taken in connection with the accompanying drawing, which shows, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein:

Figure 1 is a plan view on a first embodiment of a machine for installing clamping or compression rings in accordance with the present invention, with parts broken away;

Figure 2 is a plan view on the housing by itself of the machine shown in Figure 1;

Figure 3 is a cross-sectional view, taken along line 3-3 of Figure 2;

Figure 4 is a plan view on the housing cover;

Figure 5 is a plan view on the left segmental slide member of the machine of Figure 1;

Figure 6 is a partial plan view on the segmental slide member of Figure 5 on an enlarged scale;

Figure 7 is a plan view on one of the segments of the machine of Figure 1;

Figure 8 is a left side elevational view of the segment of Figure 7;

Figure 9 is a plan view on the segment of Figure 7;

Figure 10 is an enlarged plan view on the segment shown in Figure 7;

Figure 11 is a plan view, similar to Figure 10, illustrating the segment used for the opposite side of the machine;

Figure 12 is a partial cross-sectional view, on an enlarged scale, taken along line 12-12 of Figure 2;

Figure 13 is a partial plan view, on an enlarged scale, showing details of the housing bottom;

Figure 14 is a plan view on the pivot plate used in the machine of Figure 1;

Figure 15 is an elevational view, on an enlarged scale, of a pivot pin used in the machine of Figure 1;

Figure 16 is a plan view on the spindle used in the machine of Figure 1;

Figure 17 is a plan view on the centering plate used in the machine of Figure 1;

Figure 18 is a view on the centering plate from above;

Figure 19 is a side elevational view of Figure 17;

Figure 20 is a partial top plan view of a modified embodiment of the machine in which the housing consists of two housing parts pivotally connected with each other;

Figure 21 is a plan view, partly broken away, of another embodiment of a machine for installing compression rings in accordance with the present invention;

Figure 22 is a side elevational view of the machine of Figure 21;

Figure 23 is a plan view on the lower part of the housing, as viewed in Figure 21;

Figure 24 is an elevational view of the lower housing part of Figure 23;

Figure 25 is a plan view on the upper housing part of Figure 22;

Figure 26 is a front elevational view of the housing part of Figure 25;

Figure 27 is a partial view, on an enlarged scale, showing details of the housing bottom;

Figure 28 is a cross-sectional view taken along line 28-28 of Figure 27;

Figure 29 is a plan view on the housing cover for the lower housing part;

Figure 30 is a plan view on the housing cover for the upper housing part;

Figure 31 is a plan view on a segmental slide member;

Figure 32 is a partial view, on an enlarged scale, showing the details of the internal surfaces of the segmental slide member of Figure 31;

Figure 33 is an elevational view of a segment for one side of the machine of Figure 22;

Figure 34 is an elevational view, similar to Figure 33, and showing a segment as used for the other housing part;

Figure 35 is a partial elevational view, on an enlarged scale, showing some details of the internal surface of the segments of Figures 33 and 34;

Figure 36 is a plan view on the spindle holder of the machine of Figure 21;

Figure 37 is a front elevational view of the spindle holder of Figure 36;

Figure 38 is a side elevational view of the spindle holder of Figure 36;

Figure 39 is a plan view on a plate member used in the machine of Figure 21;

Figure 40 is a plan view on the slide carriage member used in the machine of Figure 21;

Figure 41 is a front elevational view, partly in cross section, of the slide carriage member of Figure 40;

Figure 42 is a right side elevational view, partly in cross section, of the slide carriage member of Figure 40;

Figure 43 is an elevational view of the spindle used in the machine of Figure 21;

Figure 44 is an elevational view of the spindle nut member used in the machine of Figure 21;

Figure 45 is a plan view, partly broken away, of a further embodiment in accordance with this invention of a machine for installing compression rings, similar to the machine of Figures 21-44; and

Figure 46 is a side elevational view of the machine of Figure 45.

DETAILED DESCRIPTION OF THE DRAWING

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, the machine for shrinking clamping or compression rings is generally designated by reference numeral **10** (Figure 1) and includes a housing generally designated by reference numeral **11** (Figure 2) which is of circular construction about the housing center **O** and includes a bottom **12** surrounded by a peripheral rim **13** terminating at radially extending wall edge portions **13′** and **13′′** to provide a cut-out or opening **14** in the housing that permits closing and opening movement of the actuating segmental slide members **20** and **20′** by way of the pivot plates **50** connected thereto and to be described more fully hereinafter. The rim **13** is provided with ten threaded bores **15** for engagement by screws (not shown) to fasten the housing cover **16** (Figure 4) provided with corresponding bores **17** which are preferably of the countersunk type so as to be able to mount the screws flush with the surface of the cover. As shown in Figure 4, the housing cover, like the housing bottom **12**, does not extend over the entire circumference but terminates at wall edge portions **18′** and **18′′** to provide a cut-out opening **19** for purposes to be described hereinafter.

Two actuating segmental slide members **20** and **20′** (Figures 1 and 5) which are of mirror-image-like construction and of which the left slide member is shown in Figure 5 are each provided with three similar elongated openings **22a, 22b, 22c** and **22′a, 22′b, 22′c**, all disposed along a constant circle **R97** and of constant radial width

whereby the end portions are rounded off by semi-circles of a radius half the radial width of the openings. Six roller members **23** (Figure 1) are mounted on six pins **24** fixedly secured in holes **25** and **26** provided in the housing bottom **12** and the housing cover **16**, respectively. The rollers **23** have a diameter nominally of the same dimension as the radial width of the elongated openings but slightly smaller so as to permit sliding movements of the slide members **20** and **20'** when actuated. This arrangement limits the actuating slide members **20** and **20'** to a purely circular movement, also made possible by the circular external surfaces **27** and **27'** of the segmental slide members **20** and **20'** which have a constant radius **R119** (Figure 5) that is slightly less than the internal diameter of rim **13**. The internal surfaces of the slide members **20** and **20'** consist each of a concentric inner surface portion **28** (Figure 6) concentric with respect to the center **O** of the machine with a radius **R72** and of a non-concentric surface portion **29** realized by radial portions with a radius **R72** but drawn about the displaced center **O'** (Figure 6). This produces internal surfaces portions **29** which have a radial spacing from the center **O** of the machine decreasing gradually in the direction of arrow **A** (Figure 6) whereby a concentric portion is connected with a non-concentric portion by way of a step **29'**.

The machine further includes four segments generally designated by reference numeral **30** and four segments generally designated by reference numeral **30'**, again of mirror-image-like construction which have each a clamping surface **31** of constant

radial dimension (Figures 10 and 11). The surface 32 of each segment 30, 30' includes a raised portion generally designated by reference numeral 33 extending in the radial direction which is of substantially constant width (Figures 7-11). The raised projection 33 is provided with an external surface portion 34 for abutting engagement with surface portions 28 and 29 on the slide members 20 and 20'. The surface portion 34 of a respective segment is thereby inclined at least in part in a manner complementary to the inclination formed by the corresponding surface portion 29. The raised portion 33 is further interrupted by a transversely extending channel 35 to accommodate a spring member, for example, a wire spring 40' schematically indicated in Figure 13.

The housing bottom 12 is provided with a recessed bottom portion 12' (Figures 2, 3, 12 and 13) and with eight guide configurations generally designated by reference numeral 40 open from above and cut into the embossed annular part 12'' of the housing bottom. The guide configuration which resembles a thunderbird-like shape includes a radial channel 41 intersected at right angle by a transverse channel 42 which terminates in finger-like end portions 43 and 43' for engagement by a wire spring 40' (Figures 2 and 13). In the assembled condition, the raised projection 33 of the segments 30 and 30' thereby engage with the radial channels 41 and therefore are constrained to radial movement as the radial position of a segment from center O gradually decreases by engagement of its abutment surface portion 34 with the surface portion 29 during closing movement of the slide members 20,

20'. The circular opening 12''' in the housing bottom 12 is indicated in Figures 2 and 12.

The segmental slide members 20 and 20' are further provided with radially outwardly extending arm portions 20a (Figure 5) whereby two pivot plates generally designated by reference numeral 50 (Figure 1) are fastened to opposite sides of each arm portion 20a. The pivot plates 50 thereby have a thickness such that the thickness of the pivot plates 50 and of the slide member 20 or 20' is substantially equal to the thickness of the machine, i.e., such that they are able to move freely in the cut-out 14 of the housing bottom 12' without projection, and in the cut-out 19 in the housing cover 16, preferably flush therewith. The pivot plates 50 (Figure 14) are provided with two bores 51 corresponding with bores 52 in segmental slide members 20 and 20' to fasten these three parts together with screws and nuts (not shown) or the like. The pivot plates 50 are further provided with a pivot bore 53 to pivotally accommodate a threaded pivot pin generally designated by reference numeral 54 (Figure 15) which is provided with trunion-like bearing surfaces 55 on opposite sides thereof to engage in the bores 53 of the two spaced pivot plates 50 fastened to the top and bottom of a respective radial arm 20a. Each pivot pin 54 is additionally provided with a threaded bore 56 at right angle to the axis of the bearing surfaces and of a thread adapted to engage with a respective threaded portion 61 and 62 of the spindle generally designated by reference numeral 60 (Figure 16) whereby the threaded portion 61 is a right-handed threaded portion and the portion 62 is

a left-handed threaded portion so that upon rotation of the spindle in one direction the pivot plates **50** are drawn together and upon rotation in the other direction, the pivot plates **50** are spread apart, imparting similar circular closing and opening motions to the segmental slide members **20** and **20'**. In order to permit threading of the pivot pins **54** on the spindle portion **62**, two nuts **63** and **64**, which form a fixed abutment when tightened together, are provided which must be removed so as to permit threading of the corresponding pivot pin on the threaded portion **62**. Moreover, the top pivot plate **50** must be disconnectable at its fastening means, for example, by unscrewing the corresponding nuts in order to install the assembled spindle **60** with pivot pins **54** mounted thereon in the bores **53**.

A centering plate generally designated by reference numeral **70** (Figures 17-19) is fastened to the housing bottom **12** by means of four bolts, screws or the like engaging in bores **71**. For that purpose, the housing bottom is also provided with four threaded bores **72** shown only in Figure 3. The centering plate **70** is additionally provided with a slot **73** in which a disk-like member **65** formed integrally with the spindle **60** or fixed thereto, for example, by welding, is adapted to rotate yet maintain its fixed, axial position.

Figures 29 and 30 illustrate, respectively, the lower housing cover **112** and the upper housing cover **116**.

O P E R A T I O N

In operation, as the spindle **60** is rotated in one direction, the radial arm portions **20a** and therewith the segmental slide members **20** and **20'** are drawn toward one another by way of the pivot plates **50** and pivot pins **54** whereby the segments **30** are moved radially inwardly by engagement of their abutment surface portions **34** with the non-radial surface portions **29**, thereby reducing the diametric dimension formed by the inner clamping surfaces **31** of the segments **30**. Rotation of the spindle **60** in the opposite direction will spread apart the arm portions **20a**. The segments **30** are not positively connected to the sliding members **20** and **20'** but are merely in abutting engagement whereby the wire springs **40'** will cause the segments **30** to follow a radial outward movement as permitted during opening rotation of spindle **60** by engagement of the surface portions **34** with the surface portions **29** that now increase gradually in diametric dimension. The spindle **60** may thereby be rotated manually, for example, with the use of a conventional socket wrench but is preferably rotated by the use of an electric, hydraulic or pneumatic motor adapted to be connected with the spindle.

Figure 20 illustrates a modified embodiment of the machine of Figure 1 in which the housing is made of two parts generally designated by reference numerals **20a** and **20a'** and pivotally connected by a hinge of conventional construction and generally designated by reference numeral **80**. In that case, the open ends of the housing parts **20a** and **20a'** must be provided with a conventional

lug, shackle or fastening plate to hold the parts together in the operating condition. Additionally, the pivot assembly **50, 53** on the side of the spindle **60** opposite the nuts **63** and **64** is then so constructed that the spindle can swing out about the opposite pivot assembly, preferably in such a manner that the swung-out pivot pin **54** is held in place along the threaded portion **61** of spindle **60**. This can be achieved in any known manner, for example, by merely removing the fastening means at **51** and **52** after installing a clamp or the like which hold together the pivot plates **50**. In the alternative, the two pivot plates **50** may already be provided with an additional fastening means, such as a screw and nut in conjunction with a spacer of appropriate length between the two fastening plates. This is also possible by the use of a two-partite construction of the two pivot plates **50** associated with a radial arm portion **20a** such that they can be opened up by disengagement of any conventional connection such as a threaded connection to be separated along an arc having its center about the opposite pivot pin to permit the pivot movement. By making the separating joints in the pivot plates in such a manner that the swingable parts of the pivot plates **50** extend over more than 180° about the bearings surfaces **55** of the pivot pin **54**, it is assured that the pivot pin **54** is not freely rotatable by itself on the spindle which might otherwise change its axial position. Additionally, the groove **73** may also be suitably curved to permit the disk-like member **65** to swing out.

Figures 21-44 illustrate a further embodiment in accordance with this invention in which the housing is of hinged construction and a different actuating mechanism is used for operating the machine. Parts corresponding to those of the embodiment of Figures 1-20 are designated by corresponding reference numerals of the **100** series ~~and therefore~~ will not be described in detail. The housing of the machine generally designated by reference numeral **110** consists of two housing parts generally designated by reference numerals **111** and **111'** (Figures 23 and 25) which are pivotally connected at the hinge generally designated by reference numeral **180** and including lugs **180a** and **180b**. Two segmental slide members **120** and **120'** are each in operative engagement with the four segments each generally designated by reference numeral **130** and located in the lower housing part **111** and by reference numeral **130'** in the upper housing part **111'**. The segmental slide members **120** and **120'** are thereby guided within recesses **112'** within the housing parts without the use of the guide rollers of the embodiment of Figures 1 through 19. However, if so desired, the guide roller arrangement of the embodiment of Figures 1 through 20 may also be used in the embodiment of Figures 21 through 43. As to the rest, the basic difference between the construction of the embodiment of Figures 1 through 19 and the construction of the embodiment of Figures 21 through 43, other than the omission of the guide rollers, resides in the fact that the segments **130**, **130'** have been made somewhat wider and are now provided with a bottom surface configuration in the bottom surface **131'** (Figure 35) forming a

centering groove by inclined flank surfaces **131''** to prevent the compression ring from escaping laterally.

For actuating the segmental slide members **120** and **120'**, the approximately radially extending arm portions **120a** thereof are connected with pressure rollers **223** (Figure 22) which are adapted to engage in guide grooves **251a** and **251b** of a slide carriage generally designated by reference numeral **250**. The slide carriage **250** includes similar top and bottom members **252a** and **252b** (Figure 22) which are interconnected by a core member **253** extending only over part of the length of the slide carriage **250**. The two pressure rollers **223** connected with each arm portion **120a** and **120a'** are thereby adapted to engage in the guide grooves **251a** and **251b** which are provided in each of the upper and lower parts **252a** and **252b**. The slide carriage **250** is slidable within the space formed by a top plate generally designated by reference numeral **260** (Figures 22 and 39) and by a bottom plate generally designated by reference numeral **260'** which is identical with the plate **260** except for the omission of the spline groove **261**. The spline connection is obtained by means of a spline member (not shown) of rectangular configuration which is secured to the carriage member **252a** in a complementary spline groove **254** (Figures 40-42) by means of screws engaging in threaded bores **255**. By engaging in the spline groove **261** (Figure 39) of the plate member **260**, the spline member secured to the carriage member **252a** prevents any lateral movement or canting of the slide carriage which is thereby constrained to rectilinear movements defined by the spline connection. The cover

plates **260** and **260'** are thereby secured to the top and bottom of the spindle holder generally designated by reference numeral **270** which is secured to the housing part **111** by means of bolts or screws or the like adapted to extend through bores **271** (Figures 36 and 37) and engage in threaded bores **210** (Figures 23 and 24) in the housing part **111**. The plates **260** and **260'** are thereby also threadably interconnected with the spindle holder **270** at the places indicated at **266a** through **266g** and **276a** through **276g** (Figures 36 and 39). The spindle holder **270** is also provided with an axial bore **277** extending in the direction of the spline connection which includes an enlarged part **277'** to accommodate the spindle nut generally designated by reference numeral **280** (Figure 44) having an enlarged head portion **281** for seating in the enlarged part **277'** of the axial bore **277** of the spindle holder. To prevent the nut **280** from falling out of the bore **277, 277'**, it is provided with an annular groove to be engaged by a snap ring (not shown) of conventional type. Additionally, the nut **280** is prevented from rotating within the bore **277, 277'** by any conventional means such as a spline connection, a pin or even a polygonal outer surface of the head portion **281** though annular bores are preferred for ease of manufacture. A spindle generally designated by reference numeral **160** (Figure 43) having an external threaded portion **161** is adapted to engage in the stationary nut **280** so that rotation in the one or the other direction will cause the spindle **160** to move to and fro relative to the machine. The forward end of the spindle is provided with an annular groove **162** whereby a pin or threaded

member suitably constructed and schematically indicated at **258** in Figure 41 engages in annular groove **162** and thus provides a positive connection between the slide carriage **250** and the spindle **160** for to and fro movement while allowing the spindle **160** to rotate relative to the carriage **250**.

To permit opening and closing of the hinged housing part **111'**, the guide groove **251** is suitably configured at its entrance by widening the same at **251b'** as shown in Figure 40 so that the upper housing part **111'** can be pivoted by swinging the pressure rollers **223** out of the guide groove **251b** when the slide carriage **250** is moved into its position in which it is furthest removed from the housing parts **111, 111'**.

The operation of the machine of Figures 21 through 44 is similar to that of the embodiment of Figures 1 through 19 in that movement of the slide carriage **250** toward the housing parts **111** and **111'** will force the pressure rollers **223** to slide along the guide grooves **251a** and **251b** causing the arm portions **120a** and **120'a** to approach one another and thereby cause the segments **130, 130'** to move radially inwardly in a diameter-reducing direction, whereby the compression ring held along the inner surfaces **131'** of the segments **130, 130'** are compressed. Movement of the slide carriage **250** in the opposite direction will again cause reopening of the segmental slide members **130, 130'**, followed by the outward movement of the segments **130, 130'** as a result of the spring action of the wire spring or the like.

The spindle **160** may again be rotated manually or by means of an electric motor, hydraulic motor or pneumatic motor. Moreover, the spindle may also be replaced by an hydraulic, pneumatic or electromagnetic piston cylinder unit for the drive, particularly in case of automatization of the machine.

Figures 45 and 46 illustrate a further modified embodiment of a machine for installing compression rings adapted to be shrunk over the object to be fastened. As the embodiment of Figures 45 and 46 is quite similar to the machine of Figures 21-44, similar parts are designated by similar reference numerals of the **300** and **400** series and therefore will not be described again. Differing from the embodiment of Figures 21-44, the guide grooves **351a** and **351b** provided in the top and bottom members **352a**, **352b** of the slide carriage **350**, of which only the top member **352a** is shown in Figure 45, extend obliquely toward the center line of the threaded spindle **460** and the spline groove **354** in a direction toward the slide members **320** and **320'** so that movement of the pressure rollers **323** in the guide grooves **351a** and **351b** in the direction away from their position will cause the arm portions **320a** and **320a'** to close the segmental slide members **320** and **320'**. This is achieved by causing the slide carriage **350** to move toward the right as viewed in Figure 45. In other words, contrary to the embodiment of Figures 21-44, in which actuation of the segmental slide members **120** and **120'** is realized by a movement of the slide carriage **250** toward the left as viewed in Figure 21 (pushing action), in the embodiment of Figures 45 and 46, actuation of the segmental slide members **320** and **320'** is realized by a movement of the slide

carriage **350** to the right as viewed in Figure 45, i.e., by a pulling movement. As to the rest, the embodiment of Figures 45 and 46 and its operation are similar to that of the embodiment of Figures 21-44 with the parts being analogously constructed. What was said with respect to the embodiment of Figures 21-44 equally applies to the embodiment of Figures 45 and 46, whereby, for example, in lieu of a manual operation of the spindle **460**, rotation of the spindle by an electric motor, hydraulic motor or pneumatic motor or replacement of the spindle by a hydraulic, pneumatic or electromagnetic piston cylinder unit is again possible.

The following dimensions in the various figures of the drawing are again merely representative of typical embodiments of this invention but are not to be construed as limitative of the invention and therefore may be varied as known to those skilled in the art. Furthermore, the dimensions indicated in the drawing may be of any appropriate unit, in the particular illustrated embodiments in millimeters. The numbers following any radius **R** illustrate typical values for such radius.

Turning first to the embodiment of Figures 1 through 19, and more particularly to Figure 2, the diameter **a** of the housing **11** is 258 mm. while the diameter **c** on the inside of the rim **13** is 239 mm. with the rim **13** having a thickness of about 9.5 mm. The thickness **b** of the housing **11** (Figure 3) is 20 mm. and the diameter **d** is 143 mm. while the depth **e** of recess **12** is 15 mm. The angular spacing between the center lines of channels **41** in adjacent configurations **40** is 45° and the angular opening between surfaces **13'** and **13''** in Figure 2 is 71°. In Figures 3 and 4, the

diameter **f** of surface **12'''** is 105 mm. and the radial distance of the innermost opening **15** from the center **O** is 59 mm. while the bores **15** are located at a radial distance of 124 mm. from the center **O**. In Figure 5, the radial width **g** of openings **22a**, **22b**, **22c**, **22'c**, **22'b** and **22'a** is 24 mm., the circumferential length of each of these openings is 22.5°, terminating in semi-circles with a radius of 12 mm. at each end. The holes **52** are spaced from one another at a distance of 12 mm. The thickness of each segmental slide member **20** and **20'** is 15 mm. In Figure 6, the lateral spacing between the centers **O** and **O'** is about 8.03 mm. with the step portion **29'** passing over into the surfaces **29** and **28** by way of a radius of curvature **R1**. The angle subtended by each internal surface portion **29** is about 19.4° while a set of surfaces **28**, **29'** and **29** extends over an angle of 45° as measured in the radial direction from the center **O**.

The width of channel **35** in a segment **30**, **30'** is 3 mm. while the thickness **i** of each such segment is 10 mm. and the distance **j** is 13 mm. (Figure 9) so that the projection **33** extends by 3 mm. The height **h** of each segment **30**, **30'** is 34.85 mm., the height **h'** being 15.75 mm., and the centers **O** and **O'** being displaced by about 7.3 mm. in the lateral direction and about 3.37 mm. in the radial direction. The surface **34** passes over into the steps **34'** and **34''** and the steps **34'** and **34''** into the radial surface **R72** by way of rounded off corners with a radius of 1 mm. The surface **34** extends over an angle of about 5.6°, and the angle subtended from the points of where the steps **34'** and **34''** pass over into the radial

distance **R72** as measured from the center **O** amounts to about 10.4°. In Figure 13, the width **k** of channel **42** is 7.5 mm., the width **l** of channel **41** is 10 mm. and the finger-like end portions **43** and **43'** end in semi-circles with a radius of **R1.5** so that the width thereof is 3 mm., and the distance of the centers of the radii for these end portions **43** and **43'** from one another is 40 mm. The centers for the radii of **R3** are spaced from one another a distance of 26 mm. In Figure 12, the distance **m** is 10 mm., the distance **n** 3 mm. and the distance **p** 5 mm. while the distance **q** is 7 mm. In Figure 14, the distance **r** is 27.8 mm., the diameter of bore **53** is about 18 mm. or slightly larger to rotatably accommodate the trunion-like bearing surface **55** of the pivot pin **54** which has an external diameter of at most 18 mm. The centers of holes **51** are spaced 12 mm. from one another and the center of bore **53** is spaced from the next-adjacent bore **51** a distance of 27 mm. The surfaces **50'** and **50''** which are parallel to one another and are spaced at a distance of 2.5 mm. at right angle to their surfaces, from an angle of 5.6° with respect to the opposite surface **53'''**. In Figure 15, the outside diameter of pivot pin **54** is 25 mm., its axial length **s** is 15 mm., the axial length of each trunion-like bearing surface **55** is 5 mm. and the diameter of each trunion-like bearing surface **55** is at most 18 mm. or slightly less to enable free rotation in bore **53**. The spindle **60** (Figure 16) has an overall length of 215 mm. with the length **u** 90 mm., the length **v** 120 mm. and the width of disk-like member **65** 5 mm. The overall length of the center plate **70** (Figures 17-19) is 114 mm., its thickness 7.5 mm., the depth of groove **73** 5.5 mm. and the width of groove **73** 5.1 mm.

The centers of each pair of bores **71** from one another is 8 mm. The spindle **60** has an external right thread **61** of M 12 and an external left thread **62** M 12 whereby bore **56** has an internal thread M 12 matching the external threads **61** and **62** of spindle **60**.

Turning next to the embodiment of Figures 21 through 44, the diameter **A** is again 105 mm. (Figure 23), the diameter **B** 144 mm., the diameter **C** 190 mm. and the overall width **D** is 230 mm. In Figure 24, the distance **E** is 150 mm., the distance **F** 22 mm., the depth **G** 17 mm., the depth **H** 12 mm. and the distance **I** 14.5 mm. while the distance **J** in Figure 23 is 110 mm. (see also Figure 25). The thickness **K** of housing parts **111** and **111'** is 25 mm., depth **L** in Figure 26 corresponding to depth **G** in Figure 24 is 17 mm. and the depth **M** in Figure 26 corresponding to the depth **H** of Figure 24 is 12 mm. As to the rest, Figures 25 and 26 are similar to Figures 23 and 24. The same goes for Figures 27 and 28, which are similar to Figures 12 and 13. In Figure 29 and mirror-image-like in Figure 30, the distance **N** of the center for the radius **R 9.5** from the outer surface of the lower housing cover **112** is 3.8 mm. while the distance **P** of the center for the radius **R 9.5** from the outer surface in Figure 29 is 46 mm. The two housing covers 29 and 30 are thereby mirror-image like.

With respect to Figures 33, 34 and 35, the dimensions of the segments **130** and **130'** are generally similar to those of Figures 7 through 10 with the exception that the bottom surface **131'** of segments **130**, 130'(Figure 35) is recessed by 0.5 mm. to avoid lateral escape of the ring to be compressed. In Figures 36, 37 and 38, the dimension **Q** is 48 mm., the dimension R 29 mm., the

dimension **S** 323 mm., the dimension **T** 20 mm., the dimension **U** 30 mm., the dimension **V** 130 mm., the dimension **W** 35 mm., the dimension **X** 10 mm. and the dimension **Y** 140 mm. In Figure 39, the dimension **Z** is 125 mm., the dimension **A-A** 133 mm. and the channel **261** 10 mm. wide and 4.2 mm. deep. The plate **260** has a thickness of 9.5 mm. In Figures 40, 41 and 42, the dimension **B-B** (Figure 41) is 170 mm., the dimension **C-C** (Figure 40) is 103.5 mm., the dimension **D-D** in Figure 40 is 66.5 mm., the dimension **E-E** in Figure 40 is 47.25 mm., the width **F-F** of the channels **251a** and **251b** is 19.5 mm., with each channel **251a** and **251b** terminating in a semi-circle with a radius of 9.75 mm. The length of channel **251a** between the centers of the radii of curvature for the semi-circular end portions is 87.73 mm. The spline channel **254** is again 10 mm. wide and the distance **G-G** in Figure 40 is 21 mm. while the distance **H-H** in Figure 42 is 142 mm. The dimension **I-I** in Figure 42 is 29 mm., the dimension **J-J** is 48 mm., the dimension **K-K** representing a diametric dimension is 21 mm., the depth **L-L** is 17 mm. The overall length **M-M** of spindle **160** in Figure 43 is 146 mm., the groove **162** is 3 mm. wide and formed by a semi-circle with a radius of 1.5 mm. and the distance **N-N** in Figure 43 is 7 mm. The external thread **161** of spindle **160** is M 14 which corresponds to the internal thread M 14 in spindle nut **280**. The outside diameter **P-P** of the disk portion **281** in Figure 44 is 30 mm. and has an axial length of 5 mm. The axial length of the bearing surface **283** to groove **282** is 25 mm. while groove **282** is 1.3 mm. wide and formed by a semi-circle with a radius of 0.65 mm. The overall axial length **Q-Q** of nut **280** is

34 mm. and the bearing surface has a diametric dimension **R-R** of 25 mm.

The dimensions of the parts in the embodiments of Figures 45 and 46 are similar to those of the embodiment of Figures 21 through 44 and any differences such as in the configuration of channels **351a** and **351b** are readily within the scope of any person skilled in the art utilizing the teachings of the embodiment of Figures 21 through 44.

Accordingly, while I have shown and described only several preferred embodiments of this invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art, and I therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

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